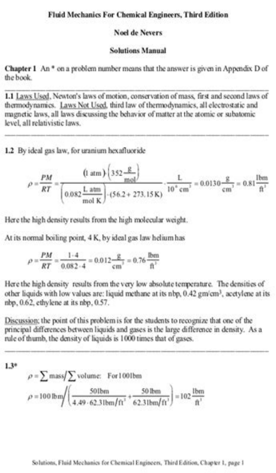

Fluid Mechanics For Chemical Engineers, Third Edition

Noel de Nevers

Solutions Manual

Chapter 1 An * on a problem number means that the answer is given in Appendix D of the book.

1.1 Laws Used. Newton's laws of motion, conservation of mass, first and second laws of thermodynamics. Laws Not Used, third law of thermodynamics, all electrostatic and magnetic laws, all laws discussing the behavior of matter at the atomic or subatomic level, all relativistic laws.

1.2 By ideal gas law, for uranium hexafluoride

$$\rho = \frac{PM}{RT} = \frac{(1\text{ atm})\cdot\left(352\frac{\text{g}}{\text{mol}}\right)}{\left(0.082\frac{\text{L atm}}{\text{mol K}}\right)\cdot(56.2+273.15\text{ K})}\cdot\frac{\text{L}}{10^3\text{ cm}^3} = 0.0130\frac{\text{g}}{\text{cm}^3} = 0.81\frac{\text{lbm}}{\text{ft}^3}$$

Here the high density results from the high molecular weight.

At its normal boiling point, 4 K, by ideal gas law helium has

$$\rho = \frac{PM}{RT} = \frac{1\cdot 4}{0.082\cdot 4} = 0.012\frac{\text{g}}{\text{cm}^3} = 0.76\frac{\text{lbm}}{\text{ft}^3}$$

Here the high density results from the very low absolute temperature. The densities of other liquids with low values are: liquid methane at its nbp, 0.42 gm/cm^3, acetylene at its nbp, 0.62, ethylene at its nbp, 0.57.

Discussion: the point of this problem is for the students to recognize that one of the principal differences between liquids and gases is the large difference in density. As a rule of thumb, the density of liquids is 1000 times that of gases.

1.3*

$$\rho = \sum\text{mass}/\sum\text{volume: For 100 lbm}$$

$$\rho = 100\text{ lbm}\Big/\left(\frac{50\text{ lbm}}{4.49\cdot 62.3\text{ lbm/ft}^3} + \frac{50\text{ lbm}}{62.3\text{ lbm/ft}^3}\right) = 102\frac{\text{lbm}}{\text{ft}^3}$$

Solutions, Fluid Mechanics for Chemical Engineers, Third Edition, Chapter 1, page 1

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